

IN THE MATTER

of the Resource Management Act 1991

AND

IN THE MATTER

of appeals lodged against proposed Plan Change 2
to the Manawatu-Whanganui One Plan

**JOINT WITNESS STATEMENT OF OVERSEER AND FARM SYSTEM
EXPERTS**

2 February 2024

INTRODUCTION

1. This joint expert witness statement relates to the appeals lodged against proposed Plan Change 2 (**PC2**) of the Manawatu-Whanganui One Plan which focuses on existing intensive farming land use activities within targeted water catchments in the region.
2. Overseer and farm system experts attending the conference were:
 - (a) Dr Jean-Paul Tavernet (**JPT**) for Overseer Ltd;
 - (b) Professor David Horne (**DH**) for Manawatū-Whanganui Regional Council (**Horizons**);
 - (c) Dr Paul le Miere (**PLM**) for Horizons;
 - (d) Dr Anne-Maree Jolly (**AMJ**) for Horizons;
 - (e) Stuart Ford (**SF**) for Horticulture New Zealand (**Hort NZ**) (via AVL);
 - (f) Dr Alison Dewes (**AD**) for Wellington Fish and Game; and
 - (g) Dr Elizabeth Parlato (**EP**) for Wellington Fish and Game and Ngāti Turanga;
3. The conference was facilitated by Environment Court Commissioner Bunting.

AGREED QUESTIONS

4. The scope of discussion was set by the Court's minutes of 6 December 2023 and 25 January 2024 and formalised in a pre-circulated agenda.

CODE OF CONDUCT

5. This joint witness statement is prepared in accordance with section 9 of the Environment Court Practice Note 2023.
6. We confirm that we have read the Environment Court Practice Note 2023 and agree to abide by it.

PURPOSE AND SCOPE OF CONFERENCING

7. Refer to paragraph [4] above.

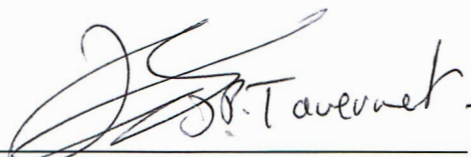
AGREED ISSUES

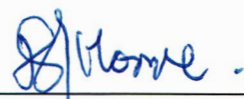
8. Refer to Annexure A.

DISAGREEMENT AND REASONS

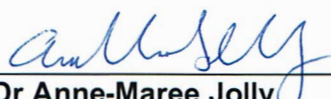
9. Refer to Annexure A.

Date: 2 February 2023



Dr Jean-Paul Tavernet

Professor David Horne

Dr Paul le Miere

Dr Anne-Maree Jolly

Stuart Ford

Dr Alison Dewes

Dr Elizabeth Parlato

ANNEXURE A

In the matter of Proposed Plan Change 2

Expert conferencing – Overseer and Farm Systems Experts – JPT, DH, PLM, AMJ, SF, AD, EP

Note: EP did not contribute to questions relating solely to Overseer, however she did contribute to questions 9, 10 & 11 relating to the risk assessment tool and the multi-evidence approach.

Issue	Agreed Position	Disagreements / Other Views
1. The attendee's views on the positions of Dr le Miere and Dr Tavernet set out in their Will Say statements on the data in the report Assessment of Overseer model performance with experimental data from grazed pastures (the Overseer Report) (Attachment 1) and any further evidence they considered to be of assistance to the Court regarding the veracity of Overseer predictions. Note: The Overseer Report is in the Court's common bundle at 301.0506	PLM provided a summary of his will-say statement dated 19 January 2024. JPT provided a summary of his will-say statement dated 22 December 2023 including an explanation of Table 1. AD endorsed JPT's will-say statement (in particular, paragraph [36], attached at Annexure B). AD and DH noted that Overseer needs to be considered as a decision support tool in the context of the wider consenting process. AMJ noted that the Overseer Report focusses on grazed pastures and not commercial vegetable growing (CVG). All agree that Dr le Miere and Dr Tavernet's will-say statements do not address CVG. However, all agree that Overseer as a model can be used across all IFLUs, notwithstanding the caveats discussed in this JWS. All agree that the Overseer Report focusses on grazed pasture as opposed to CVG. Further, SF and AMJ agree that the findings of the Overseer Report cannot be extrapolated to CVG. All agree that the Overseer Report is the best analysis of the variability of measured vs predicted losses on farm. DH, AD,	JPT disagrees with PLM's will-say statement. In particular, JPT disagrees with paragraph [9] because PLM assumed uncertainty is constant so PLM's analysis is not accurate. (PLM explained that his exercise tried to provide the level of precision of accuracy of Overseer from the Overseer Report with the data available). All experts acknowledge the complexity of this process. DH and AD have confidence in using a goodness of fit analysis approach given the complexity. PLM takes on board JPT's comments. The MPI and Overseer Reports remain the best validation data we have available. AD and JPT disagree with SF and AMJ. In AD's view, cropping only is covered in the Overseer Report.

Issue	Agreed Position	Disagreements / Other Views
	and AMJ agree that Overseer has a satisfactory goodness of fit between predicted and measured N loss. Overseer provides an estimated N loss value. The actual N-loss value at the farm level that Overseer attempts to predict is unknown in an exact sense because of the uncertainties associated with sample-based measurements (all agree with this statement from paragraph [28] of JPT's will-say statement). However, given the difficulty of modelling a complex process and the variability of the measurements, at this point it is not possible to quantify the error of Overseer predictions for an individual farm. All agree that Overseer is a useful decision support tool for assessing risk of N loss – see below regarding combined scorecard.	PLM and AMJ's views are that, in a regulatory environment, an R^2 value of 0.5 shows too much variability to use it at an individual farm level. Therefore, Overseer should not be used for absolute numbers (as in Table 14.2). JPT's view is that an R^2 value of 0.5 needs to be compared with the level of the complexity of the model. AD and JPT are comfortable that the Overseer predicted N loss values are close to the measured N loss at the individual farm level. Therefore, Overseer is an appropriate decision support tool – but see below regarding combined scorecard. SF's view is that the uncertainty of CVG inputs is much greater than the uncertainty of pastoral inputs because of the following limitations: - The gross nature of the input of time steps used in entering data into Overseer (monthly data is the finest input timeframe) are unable to accurately reflect the complexities of relatively fine scale vegetable production systems. - Overseer is not currently capable of modelling all possible crop types and therefore forces the modeller to choose proxy or surrogate crops to represent the crop being analysed. - The number of work arounds that are required to model a CVG operation. - Overseer is a long term averaging tool which has a fixed, and somewhat limited, array of long term climatic data

Issue	Agreed Position	Disagreements / Other Views
		which it uses to spread the climatic data entered over, which represents an average of thirty years data. - The lack of research results for the diverse CVG operations which can be used to verify the accuracy of the modelling.
2. Which of the data points on Figure 1 of the Overseer Report are from farms in the Manawatu/Whanganui region and what are the rainfall and soil characteristics in each case? Which of the graphs in Attachment 1 are most representative of/applicable to the Manawatū-Whanganui Region?	There are 2 points which represent the Manawatu/Whanganui region (both in Tokomaru). Both had rainfall between 878 to 1096mm. Both had pallic soil type. None of the graphs are representative because there are only 2 points from the Manawatu/Whanganui region. However, Graph 7 is slightly better than Graph 6 because it includes less data points from outside the Manawatu/Whanganui region.	
3. What does the data contained in both the Overseer Report and the MPI report Refining estimates of nitrogen leaching for the New Zealand agricultural greenhouse gas inventory (Attachment 2) tell us about the veracity of Overseer predictions?	Figure 1 in the MPI report (Attachment 2) includes 9 data points within the Manawatu/Whanganui region. Noting this only covers pastoral farm systems. This shows that 2 independent sets of analysis (the Overseer Report and MPI report) have shown similar results. The independent MPI report confirms the goodness of fit of Overseer predictions. DH and AD agree that Overseer is currently the best tool for predicting N loss from the root zone. AMJ & SF: The MPI report discusses some more representative CVG farm systems. It highlights that the Overseer crop model is not as well tested compared to the pastoral model and what testing of the crop model that has been completed highlights variability in measured vs modelled data. AMJ and SF note that when it did look at	PLM and SF note that there is still a significant amount of variability between the measured and the modelled N loss in the MPI report (particularly below the 40kg measured threshold) which is similar to the Overseer Report. While JPT agrees that the crop model was not well tested in 2021 (when the MPI report was published), JPT disagrees that the crop model is not well tested now as it has been revised and updated since the MPI report (however, AMJ notes that these updates are not provided in any of the reports in evidence).

Issue	Agreed Position	Disagreements / Other Views
	CVG, there were no data points from the Horizons region and the crop rotations for CVG in the Auckland region were the most representative of the Horowhenua region.	
4. Does the example in Attachment 3 accurately or otherwise demonstrates an effect of Dr le Miere's calculations, ie: (a) Is there a likelihood that uncertainty in Overseer predictions means that some farms with predicted CNLMs greater than the relevant Table 14.2 limits have actual nitrogen losses that are less than the relevant limits? If so, please quantify the extent of the issue, including numbers and scale of prediction errors, as far as possible. (a) Is there a likelihood that uncertainty in Overseer predictions means that some farms with predicted CNLMs less than the relevant Table 14.2 limits have actual nitrogen losses that are greater than the relevant limits? If so, please quantify the extent of the issue.	All agree that there is a likelihood that some farms will be under and over the measured N loss. There are assumptions used within the model which means the model does not completely represent reality. There are also uncertainties with the inputs into the model which can be quantified. However, without more information about the assumptions within the model, the overall likelihood of an individual farm being under or over the measured amount and by how much is not able to be provided.	JPT's view is that the likelihood of a farm being under or over the measured amount and by how much could be calculated (see paragraphs [31] & [32] of JPT's will-say statement). PLM and SF are concerned that this calculation only takes into account the uncertainty of the inputs and not the veracity of the model itself.
5. Are the percentages in Table 1 of Dr Tavernet's will-say statement the best currently available estimates of percentage uncertainty or variability in Overseer predicting nitrogen losses from individual farms.	All agree that the percentages in Table 1 do not estimate the accuracy in Overseer predicting nitrogen losses from individual farms. In an initial analysis, JPT identified climate and soil as key drivers for N loss from the root zone only. JPT clarified that Table 1 deals with the variability/uncertainty of these key inputs (climate and soil) into Overseer, not the accuracy of the Overseer predictions of actual N loss. Accuracy of	

Issue	Agreed Position	Disagreements / Other Views
	Overseer's predictions of actual N loss is a completely different exercise. All agree that Table 1 does not include CVG, it only includes pastoral. Experts discussed terminology. All agreed with definitions set out at paragraph [19] of JPT's will-say statement (and reproduced below): - Accuracy: measure how closely Overseer's predictions align with observed data from various agricultural system - Precision: assess the consistency/reliability of Overseer's predictions across multiple trials - Bias: overestimates or underestimates of observed data - Uncertainties: range of confidence associated with Overseer's predictions	
6. If any experts answer 'no' to question 1 above, can the attendees agree on an alternative set of estimates?	See answer to question 4.	
7. Using the agreed estimates determined above, and probability analyses if necessary, what is the implication of that in terms of the percentage of farms that might be placed in an incorrect activity status by an under estimation or over estimation of N loss relative to Table 14.2?	N/A	
8. Are Overseer predictions for farms in the priority subzones based on appropriate calibration either locally or in other areas with generally similar biophysical characteristics?	AD and DH say yes because the Overseer has been informed by science which has been sourced from typical farm systems which are represented in the Manawatu/ Whanganui region.	AMJ and DH noted that the NRAT has been validated in the Horizons region and uses Horizons rainfall and soil information. JPT added that Overseer also uses this information.

Issue	Agreed Position	Disagreements / Other Views
9. In the AbacusBio peer review report, Appendix Table 1.1 (Attachment 4) shows Model R^2 values of 42.6% for N loss prediction and 43.2% for N loss transportability. It is understood that this is based on the nitrogen risk scorecard absent the biophysical characteristics proposed in PC2. To what extent might it be expected the R^2 values would change with the inclusion of those biophysical characteristics (Profile Available Water and rainfall) as has been proposed?	The experts note that it is not proposed to include biophysical characteristics in the scorecard aspect of the NRAT, they sit outside of the scorecard itself. Biophysical characteristics informed the targets set in the NRAT matrix. If the biophysical characteristics were included in a manner that allowed calculation of the effect on R^2, then this value is likely to increase. When DH conducted this exercise (a similar exercise as AbacusBio but with the inclusion of biophysical characteristics), there was an indicative R^2 value of 0.7 (JWS 3 February 2023. Common bundle: 204.2363). JPT notes that the validation is done on dairy, not on cropping/CVG.	AD disagrees with the AbacusBio report and comments by the other experts. AD does not agree with the fundamental assumptions in the AbacusBio report because the NRS data was derived from self-reporting by farmers in the Fonterra Dairy Records with no cross-checking for validity (see pg 5 of AbacusBio report). PLM: Fonterra states that their Sustainable Dairy Advisors (SDAs) verify the farm dairy records.
10. From a farm systems perspective, how might a multiple evidence approach, using both Overseer and the nitrogen risk assessment tool or another tool, work in practice. (Please refrain from commenting on planning matters.)	All agree that Overseer should not be used for absolute numbers. EP abstained as she did not feel comfortable with the planning aspect of this. All experts see potential for the various tools (Overseer, NRAT, combined scorecard) to be used in practice as decision support tools to reduce N leaching. All agree that a multiple evidence approach could be developed using both Overseer and the NRAT (so both tools may be used in the consenting process). Suggestions discussed: - PLM: NRAT as drafting gate, Overseer as sense check. - AD and DH: Combined approach – do Overseer, then take Overseer outputs and put them into scorecard as a storytelling tool. AD produced some examples of a combined scorecard which includes Overseer outputs in it. These are attached as Annexure C. AD and DH to look at inclusion of Overseer outputs in the pastoral NRAT.	SF: Overseer and the NRAT are used for different purposes. The NRAT is used to identify practices that can be changed to lower your risk of N leaching. Overseer gives one estimate of N leaching which means that the user has to interrogate the data in Overseer to work out how they can lower their estimated N leaching result. The two may be able to be used in conjunction. JPT disagrees with SF because NRAT is more to reduce N surplus and not N leaching, as is shown in the AbacusBio peer review report which shows model R^2 values of 42.6% for N loss prediction and 43.2% for N loss transportability. PLM: To address the shortcomings of Overseer, it would be more appropriate to use the NRAT as a drafting gateway backed up with Overseer as a sense check. SF: For the CVG sector, there is no point in carrying out an Overseer model because of the problems caused by the difficulty in accurately modelling and therefore the results

Issue	Agreed Position	Disagreements / Other Views
	- EP: Both Overseer and NRAT completed simultaneously (Overseer <u>and</u> NRAT rather than Overseer <u>or</u> NRAT).	are not accurate enough to give growers confidence that they can use them. JPT disagrees with SF because further cropping improvement has been made to Overseer and, in his view, the Overseer model is now improved for CVG. AMJ's view is that, although there are challenges and limitations with modelling CVG in Overseer, she acknowledged that improvements have been made. When appropriate work arounds and assumptions are made, CVG can be modelled in Overseer. Overall, her preference if she had to choose one tool, it would remain NRAT. However, both tools could be used in a consent application, with preference of NRAT followed by Overseer. EP, AD, DH, AMJ and JPT noted that the NRAT has not been examined with the same level of scrutiny as Overseer. AD and JPT's view is that the NRAT should not be used in isolation. Therefore, EP, AD and JPT consider that we don't have a good understanding of the NRAT's limitations and it should be examined further before decisions are made about its use.
11. Any other relevant technical information the experts consider the Court should take into account regarding the veracity of Overseer predictions.	Table 1 of the Overseer Report has been updated by JPT and is attached at Annexure D. The methodology flows through to the updated table. With the latest version 6.5.4 of Overseer, the goodness of fit has improved to "very good" (according to Moriasi et al. 2007 which looks at catchment watershed models). At a catchment level, more Overseer data at individual farm level is more useful. PLM notes that there is more validation data available such as the Rotorua 2020 report and Lincoln University report which could be useful.	

Annexure B: Extract of paragraph [36] of Dr Tavernet's will-say statement dated 22 December 2023

[36] Finally, I would like to recall to the court that no other model has been subject to the same degree of widespread validation and scrutiny as Overseer and that, as a result, good modelling practices have been improved, making the Overseer model the leading tool in NZ for assessing N-loss impact from farm management practices. Here are the advantages across some fields:

- (a) The assumptions and limitations are published and well-known
- (b) All technical manuals of the model are publicly available
- (c) Monitoring and updating the model with the most recent published data
- (d) Continuous improvement via collaborations with scientists
- (e) Validation of the model
 - (i) Comparisons with real data
 - (ii) Sensitivity analyses, local and global
 - (iii) Uncertainty analysis
 - (iv) Scenarios testing
- (f) Collecting high-quality data: participation in the SLMACC projects
- (g) Rural professionals trained to minimise abuse and maximise the benefits of Overseer
- (h) In addition, Overseer estimates the losses of different nutrients as well as GHG emissions, making it possible to assess in tandem the combined pollution effects on water and emissions when, for example, a mitigation is introduced. This helps avoid pollution swapping where a mitigation might for example reduce one type of pollution but increase another.

Annexure C: Examples of combined scorecards provided by Dr Dewes

DAIRY ENVIRONMENTAL IMPACT ASSESSMENT

Broadlands Dairy - 2017/2018

401.0415

	DEFINITION	1. LOW RISK - EXCELLENT PERFORMANCE	2. LOW - MEDIUM RISK	3. MEDIUM RISK	4. MED- HIGH RISK	5. HIGH RISK- NEEDS ATTENTION	Risk Rating	National Best	Regional Best
Productivity Measures	EBIT per KG of N lost to water				\$24.71		4	\$105.62	\$74.22
	KG MS per KG of N lost to water					7.65	5	50.68	28.85
Efficiency Measures	GHG KG per KG MS					16.17	5	10.98	12.27
	N conversion efficiency %				18.00		4	33.00	32.00
	KG fertiliser N applied per ha				225		4	19	19
Nutrient Risk Measures	KG N lost to water per ha					113	5	17	29
	KG P lost to water per ha				2.50		4	0.40	1.20
	% Farm Cropped for Winter Feed	0.00					1	0.00	0.00
Effluent Management	KG N/ha applied as effluent on effluent block				138		4	34	68
	% Effective Area receiving Effluent				33		4	69	69
	Dairy effluent storage risk assessment								
Soil Quality & Protection	% Effective Area in Slope >7°	4.10					1	0.00	1.78
Waterway Management	% SDWA fencing completed	100					1	100	100
Sustainability	KG PKE per cow wintered	0.00					1	0.00	0.00
Biodiversity Support	% non-Effective Area					0.19	5	1.38	0.61
Adapted from: Dewes, A. M. (2014). Economic resilience and environmental performance of dairy farms in the upper Waikato region. (Masters Thesis).						Risk Rating	48	30	38

WAI KŌKOPU HEALTH EVALUATION CRITERIA

				1. Excellent performance or in line with best management practices	2. Good performance, low risk	3. Average performance, moderate risk	4. Poor performance, needs attention, higher risk to environment	5. Urgent action required: non-compliant very high risk to receiving environment	% Risk Category	% of Total Impact
NITROGEN	Kg N Leached per Ha	Kg N/ha/yr	0 to 20	20 to 29	30 to 39	40 to 45	46 plus			
	Nitrogen load from Root Zone ("hottest block")	Mg/kg	0 to 2	2 to 3	4 to 5	6 to 7	8 plus			
	Nitrogen Fertiliser per Ha	Kg/Ha	0 to 29	30 to 50	51 to 80	81 to 110	110 plus			
	Nitrogen Surplus kg N per Ha	kg	0 to 79	80 to 99	100 to 129	130 to 169	170 plus			
	Phosphorus Loss per Ha	Kg/Ha	0 to 0.5	0.5 to 1	1.1 to 1.5	1.6 to 2	2.1 plus			
PHOSPHORUS	Olsen P tests on Farm	mg/kg	0 to 15	16 to 20	21 to 25	26 to 40	41 plus			
	Cadmium tests in soil	Mg/kg	0 to 0.1	0.2 to 0.4	0.5 to 0.6	0.7 to 0.8	0.9 plus			
	Phosphorus Use Per Hectare (total effective area)	Kg/Ha	0 to 1	2 to 4	5 to 9	10 to 14	15 plus			
	Olsen P Management (pumice)	Olsen P	All soils fall within the optimum range, and regular monitoring is being done to reduce P use where possible.	Olsen P levels are above optimum, but management and monitoring is in place in order to reduce P use, and fall back to optimum range.	Olsen P is close to optimum, but monitoring & budgeting not done.	Soil Olsen P levels are high. Not using nutrient budget.	Soil P levels are high, and continuing to use P. Irregular soil monitoring.			
	Olsen P for Pumice/Ash Soils ideally is not needed to be above 20 for 90% pasture production									
PATHOGENS	Meets N load on Effluent Block (higher is riskier) N	Kg/Ha	0 to 100 Kg N total/ha loading	101 to 120 Kg N total/ha loading	121 to 150 Kg N total/ha loading	151 to 200 Kg N total/ha loading	> 200 Kg N total/ha loading			
	Effluent Storage Capacity	Lined Pond and Capacity (25%)	Pond is fully lined with an impermeable liner. Capacity checked using latest pond storage calculator tool (qualified person).	Pond is lined or clay sealed, can provide engineer report. Adequate storage for breakdowns and to allow for low risk effluent application to land	Effluent storage is a holding pond that is regularly emptied in a low risk way to receiving land. Pond has not been tested by the PSC. Sealing of the pond may be required, or a new pond constructed. The farmer is investigating this process.	Insufficient capacity to hold effluent over high risk or emergency times. Pond is able to overflow in high risk times, or could have contact with groundwater (seepage).	Sump or holding capacity is for emergency only. There is not sufficient capacity for deferred irrigation of any type. There is potential for surface and groundwater contamination.			
	Meets Requirements for Herd & Farm System	Compliance with regional rules	Farm system has been reviewed, effluent storage and N loading is better than required by permitted activity rules for BOP Region.	Farm system reviewed, storage being increased, extensions planned to effluent area to improve nutrient efficiency.	Farm effluent system is adequate for storage, meets present rules. Pond capacity marginal when checked on Pond Storage calculator.	Effluent Storage is just keeping up with demand. OVERSEER Analysis indicates larger area required to meet N loading requirements.	Indications of non compliance and storage or extension required to reduce risk.			
	Management of Dead/Fallen Stock, and Offal Hole Permeability.	Removal	All dead stock are removed from farm (picked up) or are in a sealed hole.	Spring time pick ups occur for all stock, and bobby calves etc, and balance of year, are buried in impermeable hole, above water table.	Some Pick up in Spring (when available) and balance of year buried.	Buried all year round, sometimes in saturated areas.	All fallen stock stay on farm, buried, unable to be above water table.			
	% of waterway fenced stock Exclusion	% of waterway fenced	1	90 to 99%	80 to 89%	50 to 79%	0 to 49%			
SOIL QUALITY & PROTECTION	Riparian Planting 1.5 – 10m	% of waterway planted. (a)	70-100% has Riparian Planting > 5m	50 to 69% planted >5m	30 to 49% planted > 5m	Has some but less than 30% planted > 5m	No planting or buffer zone on stream banks			
	Wetlands fenced and protection/enhancement of ephemeral waterways. (20%)	% protection	100% Wetlands and ephemeral stream areas are fenced and stock is permanently excluded	Most of the wetland areas are fenced off most of the time.	Wetlands are planned to be fenced and protected/planted in next few years (plans with Council for fencing underway)	No wetland protection is in place/ nor planned	Wetlands are drained and managed for pasture.			
	% Bare Soil and Cropping – Sediment Loss Risk	Runoff	No cropping, all minimal till, no bare soil at any time of year.	Some grass to grass, full cultivation, on flat land (<2% of area).	Full cultivation on areas, (ie Maize) bare soil for longer than 3 weeks.	Cultivation, slope, bare soil for periods	Cultivation, bare soil, slope areas, >5% of total farm area.			
	Protection of Slopes	Pugging, Erosion, Sediment	No large (>300 kg) animals on steep (>20 degrees) slopes. Sheep only. Retiring hillsides.	Cattle on hillsides <5% of time. Not in winter. Retiring land above 20degrees.	Cattle on slopes, and hillsides 50% of time. Some retirement happening	Cattle on slopes (>400 kg) and >20 degrees as part of normal farming system. Considering change	Cattle on slopes, no change planned next 3 years			
	WATER USE Irrigation & Soil Moisture Monitoring	(d) Latest precision tools used to minimise water use and maximise efficiency for irrigation	Soil moisture monitoring (tensiometers used) precision application technology used when irrigating. Water efficient crops used (not pasture), fully aware/reporting all water use per annum.	Low rate application used, drip irrigation.	No Soil moisture monitoring, good quality pasture/horticultural crops only is watered.	High rate applications, no monitoring, low fertility low yield pastures/crops irrigated.	Spray irrigation, no monitoring, no reporting.			
WATER HEALTH	Water Health – Drinking water safety and health	Testing your water	All water is sourced from safe, tested, monitored sources for all staff and homes	House water is checked and filtered. (provide tests) Note nitrates not removed.	Regularly (annually) monitor ground or surface drinking water for nitrates and pathogens and ensure safety for users. (note that filters do not remove nitrogen).	Growing awareness, but not testing.	Never tested, and not aware of risks/changes to policies (Three water reforms)			

(a) Appropriate Setbacks for Riparian Planting (Wildlands consultants appendix 5) The Proposed National Environmental Standard for Plantation Forestry Discussion Document(MJE 2010) (b) This relies on assessing the farm against the Dairy NZ Code of Practice for Effluent (version 2, 2013) The pond storage calculator (PSC) must be the most up to date version and storage capacity checked against PSC output. (c) Smart Water Use on Dairy Farms – Assessment Workbook and Technical Manual. (d) The "Irrigation guide", "NZ Irrigation manual" & "Guide to good irrigation": Dairy NZ.

WAI KŌKOPU HEALTH EVALUATION

WAI KOKOPU HEALTH EVALUATION												
		1. Excellent performance	2. Good performance, low risk	3. Average performance, moderate risk	4. Poor performance, higher risk	5. High Risk, non-compliant	THE IDEAL	FARM NAME	IMPACT SCORE	FARM RATING	WEIGHTED SECTION	
NITROGEN	Kg N Leached/Ha	Kg N/ha/yr			☹️			< 20	25	3	30%	12%
	Nitrogen load from Root Zone	Mg/Kg				☹️		< 2.5	7	4	4%	
	Nitrogen Fertiliser/Ha	Kg/Ha		😊				< 80	20	2	8%	
	Nitrogen Surplus kg N/Ha	Kg					☹️☹️	< 50	139	5	6%	
PHOSPHORUS	Phosphorus Loss per Hectare	Kg/Ha					☹️☹️	< 1.5	2	5	4%	10%
	Olsen P tests on Farm	Mg/kg				☹️		<25	25	4	8%	
	Cadmium tests in soil	Mg/kg					☹️☹️	< 0.8	1	5	2%	
	Phosphorus Use Per Hectare	Kg/Ha	😊😊					< 10	1.00	1	20%	
	Olsen P Management	Kg/Ha					☹️☹️	Optimum with Budgeting	Levels high, continued use, no monitoring	5	6%	
PATHOGENS	Meets N load on Effluent Block	Kg/Ha				☹️		<150 Kg N/Ha	200	4	10%	9%
	Effluent Storage Capacity						☹️☹️	Lined Pond and Capacity 25%	Sump or holding capacity is for emergency only	5	5%	
	Requirements for Herd & Farm System		😊😊					40%	Farm system reviewed effluent & N loading better than required	1	25%	
	Management of Dead Stock & Offal Hole						☹️☹️	Nil	All fallen stock stay on farm, buried, unable to be above water table.	5	5%	
SOIL QUALITY & PROTECTION	Waterway Fenced for Stock Exclusion	%				☹️		1	80%	4	8%	20%
	Riparian Planting 1.5 – 10m	%		😊				>70% >5M	>50% planted >5m	2	16%	
	Wetlands Fenced & Protection Waterways	%					☹️☹️	>70% enhanced	Wetlands are drained & used for pasture.	5	4%	
	Protection of Slopes		😊😊					Nil	No cropping, all minimal till, no bare soil at any time of year.	1	20%	
	No Large animals on Steep Slopes			😊				Nil	On hillsides <5% of time excl winter, Retiring 20°	2	16%	
WATER	Water Use - Irrigation		😊😊					Precision Irrigation used	Soil moisture monitoring precision technology used. Water efficient crops used.	1	50%	9%
	Water Health – Drinking Water Safety			😊				Safe source guaranteed	Checked and filtered. Nitrates not removed.	2	40%	
OVERALL IMPACT RATING:										66	60%	

Annexure D: Updated Table 1 of Dr Tavernet's will-say statement

